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ECHINODERMS FROM THE NORTHERN COAST OF YUCATAN AND THE HARBOR OF VERA CRUZ.

BY J. E. IVES.

The Echinodermata which form the subject of this paper were collected on the northern coast of Yucatan and at Vera Cruz, in the spring of the present year, by an expedition from the Academy of Natural Sciences of Philadelphia to investigate the natural history of Yucatan and Mexico. The writer, who was a member of the expedition, is indebted to Professor Angelo Heilprin, the Director, for the opportunity of working up this portion of the collection.

The results in this department are interesting. One new genus and three new species are described in the following pages, a little known species is figured for the first time, the synonymy of this species and of some others has been studied with profitable results, and the majority of the species collected supply new localities which form connecting points between the northern and southern portions of the great West Indian, or eastern tropical American littoral fauna.

The northern coast of Yucatan possesses a sandy beach largely made up of shell fragments. The water, off the coast, is very shallow, the 10 fathom line being 20 miles from the shore, and the 100 fathom line about 150 miles. Three miles off the shore, in the neighborhood of Progreso, the bottom is of a sandy character, although a few small corals were brought up in the dredge. Along the shore to the westward of Progreso is a small Serpuloid reef. Large quantities of sea-weed and sponges are thrown upon the beach and lie decomposing in the sun. These and numerous water-worn specimens of *Orbicella annularis* and a large Escharine species of Bryozoan, with some specimens of *Xiphogorgia anceps*, indicate the existence of a region rich in animal and vegetable life not very far from the shore. The following species were collected on this coast in the neighborhood of Progreso and the Port of Silam: *Holothuria Heilprini, Holothuria Silamensis, Holothuria nitida, Toxopneustes variegatus, Echinaster Brasiliensis* and *Luidia alternata.* No Ophiurans were found on the beach, or in the dredgings off the shore, although careful search was made for them.

The harbor of Vera Cruz is an area of luxuriant coral growth, madrepores and brain corals being especially abundant.[1] No holothurians were collected here, but on the other hand two species of ophiurans were obtained. The forms from this locality are the following: *Diadema setosum*, *Echinometra subangularis*, *Mellita pentaporus*, *Thyraster serpentarius*, *Astropecten articulatus*, *Ophiura cinerea* and *Ophiothrix angulata*.

After the detailed account of the species collected which follows, in which they are separated into the two regions from which they were obtained, I have advanced some general considerations based upon their geographical distribution. A chronological list of all the important memoirs dealing with the Echinoderms of the West Indian region, has also been compiled which I believe will be of use in the future study of this area.

YUCATAN.

Holothuria Heilprini, n. sp. Pl. VIII, figs. 1–6.

Body cylindrical, narrowed toward the anterior end. Specimen very much contracted, probably to half the length of its extended condition. Anus round.

A few large wart-like prominences scattered over the dorsal surface, each surmounted by a papilla containing a rudimentary terminal plate and smooth rib-like rods with the ends enlarged and perforated. Pedicels present upon the dorsal and ventral surfaces: upon the dorsal surface they are evenly distributed and are slightly smaller than those of the ventral surface. The ventral pedicels are very numerous and closely approximated. In the specimen collected there is no trace of a linear arrangement.

The specimen obtained has ten tentacles, the most ventral of which is much smaller than the rest.

The body wall is very thick in the much contracted example.

The calcareous ring is very similar to the figure of that of *Holothuria Floridana* given by Selenka[2] in his "Beiträge."

There are two bundles of short madreporic canals attached to the dorsal surface of the œsophagus on the right and left sides respectively of the dorsal mesentery. In the specimen obtained there are twenty canals on the right side and nineteen on the left.

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[1] See Professor Heilprin's Report upon "The Corals and Coral Reefs of the Western Waters of the Gulf of Mexico" in this volume, p. 303.

[2] Zeit. wiss. Zool. Bd. xvii, pl. xviii, fig. 47.

The distal portions of the canals are enlarged, so as to form elongated heads. Two of the canals on the left side are branched, thus possessing two heads.

A single long and slender Polian vesicle exists, which is more than half the length of the animal, and terminates in a vesicular enlargement of considerable size.

Cuverian organs are not present.

In the walls of the dorsal pedicels are tables of the ordinary type described below, and a few rosettes. Around the terminal disks there are also tables which lack disks, the four rods bending inwards and uniting at the point where they meet. The ventral pedicels occasionally possess a few diskless tables around the edge of the terminal disk similar to those of the dorsal pedicels, and their walls contain a few rosettes. The calcareous deposits of the body-wall are collected into heaps which give its surface a granulated appearance. They consist principally of rosettes which occur in great abundance. They are usually about ·015 mm. in diameter. The branches of the rosettes, in rare instances, coalesce to form irregular perforated plates. On the dorsal surface the accumulations of rosettes are accompanied by a number of tables, which possess well developed disks and are of the *Holothuria atra* type, usually with a hole at the base of each rod. Exceptionally the hole is absent or it may be represented by two or three similar holes. The rods are connected by a single cross-bar. Each of the rods is surmounted by three prominent teeth, two horizontal and one vertical. The height of the tables and the diameter of their disks is about ·1 mm. The tables are almost entirely absent from the accumulations of the ventral surface.

The color in alcohol, of the granulated portion of the body is a dirty olive green; the portions free from deposits are slate-color with a purplish tinge; the sides of the pedicels grayish and their disks straw-color; tentacles very light straw-color.

Length of the much contracted specimen about 80 mm.

Collected among the wet seaweed of the beach at the Port of Silam.

I have named this species after Professor Angelo Heilprin, the Director and promoter of the expedition.

This form is related to *Holothuria atra* of Jæger. The most prominent difference is the arrangement of the calcareous deposits into heaps in *Holothuria Heilprini,* producing an appearance of granulation over the surface of the body. The branches of the rosettes also, in this species, very rarely coalesce to form plates, and the wart-like prominences sparsely scattered over the dorsal surface are also a distinguishing feature. True papillæ are confined to the summits of these prominences, and the remainder of the dorsal surface is evenly covered with pedicels only slightly smaller than those of the ventral surface. In the superficial appearance of granulation it resembles *Holothuria grisea* of Selenka, but the deposits of this species are collected into circles, and not heaps. It also differs from *Holothuria grisea* in the fact that the disks of the tables have a hole at the base of each rod and are not provided with spines, and that there are two well developed bundles of madreporic canals, instead of a single free canal.

Holothuria Silamensis, n. sp. Pl. VIII, figs. 7–9.

Body cylindrical, equally rounded at both ends, about three times as long as broad. Anus round, not stellate. Surface smooth to the touch. Dorsal and ventral surfaces possessing pedicels of small size, more numerous upon the ventral than upon the dorsal surface, but not crowded. The ventral pedicels show an imperfect arrangement in three rows, of which the middle row is the widest. A few papillæ are scattered amongst the dorsal pedicels.

The pedicels possess a well developed terminal disk. In two out of many pedicels that I examined I found extremely rudimentary tables around the edge of the disks. The tables are apparently of the type which is found in its perfect form in *Holothuria atra*.

In the one case there were two present and in the other, one. These must be regarded as exceptional structures as I did not find any trace of tables elsewhere in the specimen. Probably they are rudimentary structures derived from an ancestor possessing tables. The walls of the pedicels are free from deposits. The papillæ contain a rudimentary terminal disk and several smooth rib-like rods with perforated ends, such as are characteristic of them. The calcareous deposits of the body-wall are not numerous and consist entirely of small, irregular, perforated plates, which are formed by the coalescence of the branches of rosettes. They usually have one diameter longer than the other; the long diameter being about ·03 mm. and the short diameter, ·02 mm. They occur in small heaps, but the heaps are not sufficiently large or numerous to produce the granulated appearance, which is possessed by the previous species.

In the specimen obtained there are twenty tentacles of nearly uniform size.

The body wall is thick.

The calcareous ring is well developed, but its component pieces are not very coherent.

There are numerous short madreporic canals, arranged in two bundles, one on either side of the dorsal mesentery above the œsophagus, three on the left side and ten on the right. The distal portion of each canal is enlarged, forming an elongated head as in the preceding species.

There is one long and slender Polian vesicle, more than half the length of the animal, with two considerable vesicular enlargements, one near its end, and the other near its middle.

The specimen possesses a very small bundle of Cuverian organs.

The color in alcohol is a dirty white mottled with dark gray. The dark gray predominates on the anterior portion of the dorsal region. The tentacles are a dirty white, the walls of the pedicels and papillæ light gray, and the disks of the pedicles straw-colored.

Length of the specimen, 80 mm.

Collected at the Port of Silam among the wet sea-weed of the beach.

This form is characterized by rosette-like plates, absence of tables, two bundles of madreporic canals, non-stellate anus, absence of wart-like prominences on the dorsal surface, general distribution of pedicels and the very small number of papillæ. The number of tentacles, presence of Cuverian organs and character of its Polian vesicle, are probably not important characters, on account of the want of stability of structure of these organs.

It falls into the section of the genus *Holothuria* defined by Théel as "possessing more or less incomplete rosettes." Seven species are included by him in this section, *H. marmorata* Jäger, *H. Argus* Jäger, *H. Vitiensis* Semper, *H. tenuissima* Semper, *H. Koellikeri* Semper, *H. clemens* Ludwig and *H. similis* Semper. He thinks it probable, however, that they represent one or more species capable of great variation. They have hitherto only been reported from the tropical Indo-Pacific region.

Holothuria Silamensis differs from all of them in the possession of two well-developed bundles of madreporic canals, instead of a single canal. It can also be distinguished from *H. marmorata*, *H. Argus* and *H. Vitiensis*, by the circular instead of stellate anus; from *H.*

Koellikeri and *H. tenuissima*, by an unequal instead of an equal distribution of papillæ over the surface of the body, and from *H. clemens* by the absence of the fifteen small papillæ which surround the anus of the latter species.

These distinctions are given for the sake of convenience. Many minor ones exist, but the difficulty, even with the characters given above, is to estimate their real value. It is possible that a larger amount of material may in the future enable us to unite these forms as varieties of one or a few species. The existence of the three rudimentary tables, previously mentioned, even suggests a relationship to *Holothuria atra* and its allies.

This species I have named after the Port of Silam where it was collected.

Holothuria nitida, n. sp. Pl. VIII, figs. 10–15.

Body cylindrical. Specimen collected, in a moderately extended condition, four times as long as broad, slightly acuminate at both ends. Surface of the body smooth. Pedicels and papillæ on the dorsal surface and pedicels alone on the ventral surface.

Dorsal pedicels not very numerous, smaller than the ventral. Containing well developed tables, of the type found in *Holothuria atra*, around the edge of the terminal disks, and also rosettes. Tables about ·1 mm. in height, and their disks about ·09 mm. in diameter. A very few imperfect tables (see Pl. VIII, fig. 11.) also occur around the edge of the disks. Rosettes usually with a longer and shorter diameter, the former being on an average ·03 mm. and the latter ·02 mm. Some very much larger rosettes of abnormal form are found in the pedicels, Pl. VIII, fig. 15. The ventral pedicels lack deposits in their walls but possess well developed terminal disks. They are arranged in three imperfect longitudinal rows, the two outer having a width of three or four pedicels, and the inner of four or five. The papillæ are arranged in a row of about seven in number along the lower edge of the dorsal surface, on either side, and in two longitudinal rows upon the intervening portion. They contain many rib-like rods with branched or perforated extremities. Tables and rosettes also are sometimes present. The deposits of the body-wall are few and consist entirely of rosettes which usually occur in very small and scattered groups. The branches of the rosettes occasionally coalesce, forming imperfect perforated plates.

There are twenty tentacles of nearly equal size.

The body-wall is moderately thick.

The calcareous ring is well developed and is of the shape given in Pl. VIII, fig. 13.

There is a bundle of five madreporic canals on the right side of the dorsal mesentery and a single canal on the left side. The canals are short and have an elongated head.

A single, long and slender Polian vesicle is present, possessing a vesicular enlargement at its distal end.

A very small bundle of Cuverian organs exists.

The sexual glands are divided.

The color of the dorsal surface, in alcohol, is indigo-black relieved by a number of large white spots arranged on either side along its edge, and also forming irregular longitudinal rows upon the intervening area. From the centres of these white spots arise the papillæ described above. The ventral surface is dirty white, speckled with indigo. Each of the interambulacral areas of the ventral surface is marked by a dark line. The pedicels and papillæ have a yellowish tint. The tentacles are of a dirty white color.

Length 35 mm.

A single specimen was collected among the wet sea-weed washed up on the beach at the Port of Silam.

It is closely allied to *Holothuria atra* of Jäger, but is distinguished by the presence of pedicels upon the dorsal surface, by the absence of tables in the integument of the body-wall and by the well-defined color pattern.

Toxopneustes variegatus, Lamk. Anim. Sans. Ver., 1816, p. 48.

A. Agassiz, Mem. Mus. Comp. Zool., Vol. III. 1872–1874, pp. 168, 289, 500. Pl. II, iva, vi, vii, xxv.

Three specimens were dredged in shallow water on a sandy bottom off Progreso and three specimens were collected on the beach. They are evidently not very abundant in this locality. None were found upon the beach at Silam.

In the specimens obtained the spines are very short and those of the abactinal surface, rather slender and pointed.

Prof. Alexander Agassiz in the Revision of the Echini mentions the presence of two specimens of this species in the Museum of the École des Mines, from Yucatan. The species was also dredged on the Yucatan Bank, by the "Blake."

This species is found throughout the West Indian region, extending northwards to Beaufort, N. C. and southwards to Armação, Brazil. Professor Agassiz also records it from Cape Dos Bahias, Argentine Republic.

Echinaster Brasiliensis, Müller and Troschel. System der Asteriden 1842, p. 22, Tab. 1, fig. 4. (?)
Perrier, Arch. de. Zool. Exp. Vol. IV, 1875, p. 367.
Lütken, Vidensk. Meddel. 1859, p. 93.
Rathbun, Trans. Conn. Acad. Vol. V, 1879, p. 148.
Ludwig, Mem. Cour. Acad. Roy. Belg. T. XLIV, 1882, No. 5, p. 7.

Two starfishes obtained upon the beach at Progreso have been referred to this species. The larger specimen is about 80 mm. in diameter. The length of the radius of the disk, to that of the arm, is about as one to five. The arms are cylindrical and tapering. The spines of the surface of the arms and disk are small, not longer than the ambulacral spines, and form nine irregular rows upon the surface of the arms. There are about twenty five spines in a row from the middle of the disk to the tip of the arm. The ambulacral spines are arranged in three more or less perfect rows. The two outer rows are of equal size and the spines are opposite to one another; the spines of the innermost row are much smaller and alternate with the larger spines.

The smaller specimen is about 70 mm. in diameter and has only seven imperfect rows of spines, with about 20 spines in a row.

The specimens when alive were of a rust-red color, darker above than beneath. In alcohol they have become a light dirty brown.

I have figured the larger of the two specimens collected, Pl. VIII, figs. 16–18.

The specimens found in Yucatan agree with the description of the forms referred by Mr. Rathbun to this species from Rio Formoso, Pernambuco, Brazil.

The synonymy of *Echinaster Brasiliensis* and of the other species of Echinaster inhabiting the western shores of the tropical Atlantic is in a very unsatisfactory condition. Müller and Troschel give *Othilia multispina* of Gray[1] as a synonym of this species, but it appears to me very doubtful if this form is the same.

The locality of the specimen described by Gray is unknown. His description runs thus: " Rays short, depressed, broad, rather more than twice as long as the width of the body, blunt at the end, with eleven rows of acute distant spines." According to Müller and Troschel their species is distinguished by its small and numerous spines. The authors who have described the form subsequently, viz Lütken, Dujardin and Hupé, and Rathbun have characterized the species principally by this character, and have associated with it that of slender arms.

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[1] Annals and Mag. Nat. Hist., Vol. VI, 1840, p. 282.

Müller and Troschel also refer to Seba's [1] figure of *Pentadactylosaster spinosus regularis virginianus* as an illustration of their species. Not only, however, is this figure entirely out of accord with their description but it is almost identical with the figure of *Pentadactylosaster spinosus regularis* of Linck,[2] which forms their type of *Echinaster spinosus*, the species described immediately before *Echinaster Brasiliensis.* Seba's specimen came from Virginia and he distinctly identified his figures with Linck's previous figure. Both figures are good representations of *Echinaster spinosus*, with large distant spines, and cannot by any stretch of the imagination be considered as identical with *Echinaster Brasiliensis.*

The figure of this species given by Müller and Troschel does not at all agree with their description of it, but rather with that of their *Echinaster spinosus.* It is possible that the figure may have been wrongly named.

If the views expressed above are correct it is very doubtful whether *Echinaster Brasiliensis* has any synonyms.

This species is distributed throughout the West Indies and extends northwards to the Florida channel and southwards to Rio Janeiro.

Florida channel (A. Agassiz). Kingston, Jamaica; Puerto Cabello; Rio Janeiro (Lütken). Brazil (M. & T.). Rio Formoso, Brazil (Rathbun). Cap Vert, Brazil, (Ludwig). Rio Janeiro, (Perrier.).

The following list represents the species of Echinaster[3] found in waters of the Western Tropical Atlantic.

Echinaster spinosus, Retzius. Dissert. Sist. Spec. Cog. Asteriarum, 1805, p. 18.

Asterias echinophora, Lamarck, Hist. Nat. Anim. Sans. Vert. t. ii, p. 560.

Echinaster sentus, Say. Jour. Acad. Nat. Sci. Phila., 1st Ser., Vol. 5, p. 143.

The two specimens referred to by Say in his description of *Echinaster sentus*, which were presented by Lieut. Gandtt, are preserved in the collection of the Academy, and after comparison of them with examples of *Echinaster spinosus* from New Providence, Bahamas, also in the collection of the Academy, I am unable to find any well marked characters separating them from the latter species.

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[1] Thesauri Vol. iii, p. 13, Tab. 7, Fig. 4.

[2] De Stellis Marinis, Tab. iv, Fig. 7.

[3] *Echinaster serpentarius* (Val.) Müller and Troschel, has been placed by the author in a separate genus, see below.

West Indies; Brazil to Virginia.

Echinaster crassispina, Verrill. Trans. Conn. Acad. Arts and Sci., Vol. 1, p. 368, pl. iv, fig. 7.

This species may prove to be a variety of the preceding species.

Bahia, Brazil.

Echinaster Brasiliensis, Müller und Troschel. System der Asteriden, p. 22. (Taf. 1, fig. 11 ?.)

West Indies; Florida Channel to Rio Janeiro.

Echinaster spinulosus, Verrill. Proc. Bost. Soc. Nat. Hist., XII, p. 386.

West Coast of Florida.

Echinaster modestus, Perrier. Nouv. Archives Mus. Hist. Nat. t. VI, p. 206, Pl. III, fig. 7.

Below 100 fathoms, West Indies.

Luidia alternata, Say. Jour. Acad. Nat. Sci. Phila. (1) Vol. V, 1825, p. 144.
Lutken, Vidensk. Meddel., 1859, p. 42.
Perrier, Arch. Zool. Expér., 1876, T. V. p. 254.
Ludwig, Mém. Cour. Acad. Royal, Belg., 1882, T. XLIV, No. 5, p. 9.
Sladen, "Challenger" Report on the Asteroidea, 1889, p. 250.
Luidia granulosa, Perrier, Ann. Sci. Nat., (5) t. xii, p. 301, Pl. II, fig. 18.
Luidia variegata, Perrier, Arch. Zool. Expér., 1876, t. v. p. 257.

A single specimen of this species was collected off Progreso at a depth of about 20 feet. The living animal was straw-colored, with black markings forming three or four irregular, transverse bands upon the dorsal surface of the arms: black markings absent from the ventral surface: spines more or less greenish: ends of the ambulacral feet orange red. The same coloration is preserved in the alcoholic specimen, with the exception of the loss of the greenish color of the spines, and of the orange color of the ends of the feet.

The distinctive characters of this species are the three well-marked rows of paxillæ on either side of the arms, and the existence of two or four imperfect rows of spines upon the dorsal surface of the arms, one or two rows on each side. In the specimen collected, there are traces of three rows of spines on either side of the arm, at its base.

A few three valved pedicellariæ exist in our specimen between the adambulacral and the ventral rows of spines. They closely resemble Perrier's figures of those of *Luidia granulosa.*

Radius of the disk 10 mm., length of an arm from center of disk, 70 mm.

This species is found in the West Indies, and extends northwards to Florida, and southwards to Bahia, Brazil.

Florida (Say). Florida Channel, 40 fms. (Agassiz). Antilles; Tortugas; Ile Breton, Mississippi R.; 60 m. N. Ile Jolbos, 14 fms.; Montserrat, 88 fms. (Perrier). St. Thomas (Lütken). Brazil (Ludwig). Bahia, 7–20 fms. (Sladen).

The following species of *Luidia* are found in the West Indian region.

Luidia clathrata, Say. Jour. Acad. Nat. Sci. Phila. (1) Vol. V, p. 142.
A. Agassiz, Mem. Mus. Comp. Zool., V, p. 117, pl. xx.

West Indies; Beaufort, N. C. to Rio Janeiro.

Luidia Senegalensis, Lam. Anim. Sans Vert. t. iii, p. 255.
Perrier, Arch. Zool. Exp., Vol. V, p. 262.

Luidia Marcgravii, Lutken. Vidensk. Meddel. 1859, p. 43.

West Indies, southward to Rio Formosa, Brazil. Also upon the West Coast of Africa (Senegal).

Luidia elegans, Perrier, Arch. Zool. Expèr., t. v, p. 256.

Florida straits (101 feet), Barbadoes (200 fathoms.)

Luidia convexiuscula, Perrier, Nouv. Arch. Mus. Hist. Nat. (2), T. VI, p. 268.

Lesser Antilles, and off S. W. of Florida. (56–208 fathoms.)

Luidia alternata, Say.

West Indies; Florida to Bahia, Brazil.

Luidia Barbadensis, Perrier, op. cit., p. 267.

Barbadoes and off S. W. of Florida. (40–209 fathoms.)

This species may be a long armed variety of *Luidia alternata.*

A complete list of the literature of these species will be found in Ludwig's List of Brazilian Echinoderms, Perrier's "Stellérides des Dragages du Blake," and Sladen's Monograph of the "Challenger" Asteroidea.

VERA CRUZ.

Diadema setosum, Gray, Ann. Phil., 1825, p. 4.
A. Agassiz, Mem. Mus. Comp. Zool. Vol. III, 1872–1874, pp. 103, 274, 408., Pls. IIb, IIc, IVa, VI, VIa, XXIV, XXVII, XXVIII.

Very abundant among the reefs of the harbor of Vera Cruz. Found upon the coral sand in shallow water or in rock and coral recesses. Especially numerous in the shallows off the Gallega reef.

This species has not before been recorded from the Gulf of Mexico. It is found throughout the West Indies and extends northward to Cape Florida and southward to Fernando de Noronha. It is also found throughout the whole tropical region of the globe with the exception of the West Coast of America.

Echinometra subangularis, Leske, 1778. Kl. Add.

A. Agassiz, Mem. Mus. Comp. Zool. Vol. III, 1872–1874, pp. 116, 283, 434, Pls. Xa, XXVI.

Svén Lovén, Bihang Kongl. Svensk. Vetensk. Akad. Handl. Vol. 13, IV, 1888, p. 153.

A large series of specimens of this species were collected at Vera Cruz. They were found in great quantities in the shallows lying to the northwest of the town, especially upon the rock and serpuloid reef known as the Caleta. They are characterized by a somewhat flattened and circular test. The spines show a great range of variation in their coloring. They are of various shades of reddish-brown, purple and olive. Some specimens are of very light tints and others are almost black. The spines are often tipped with different colors.

This species is found throughout the West Indies, and as far northward as Charleston, S. C. and southward as Desterro, Brazil. It is also found upon the West coast of Africa, and at Ascension Island.

Mellita pentapora, Gmelin, 1788, Linn. Syst. Nat. 3188.

Mellita testudinata, Klein,[1] 1734, Nat. Disp. Ech., p. 30, Pl. XXI, fig. C. D.

A. Agassiz, Mem. Mus. Comp. Zool., Vol. III, pp. 141, 322, 538, Pls. XI, XIIa, XIIc.

This form is very abundant in some places upon the beach at Vera Cruz.

The specimens collected are considerably shorter in their antero-posterior diameters than the typical forms of this species. Both Klein and Louis Agassiz[2] based their description of *Mellita testudinata* upon specimens received from Vera Cruz, and it is an interesting fact that the figures given by each of these authors illustrate this peculiarity. Evidently it represents, not an individual variation, but a local variety. The typical form is seen in the figure given by Professor Alexander Agassiz in his Revision of the Echini.

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[1] As Klein's names are not admissible under the British and American Association rules, I have adopted the first post-Linnæan binomial, viz, *Echinus pentaporus* of Gmelin.

[2] Monographie d' Echinodermes. Des Scutelles, 1841, p. 40, Tab. 4a, figs. 7–10.

This species is found in the West Indies, extending northward as far as Cape Hatteras, and southward to Itabapuana, (100 m. N. E. Rio Janeiro) Brazil.

Professor Verrill in his Report upon the Invertebrata of Vineyard Sound says that the specimens found north of Cape Hatteras are rare and dead.

Thyraster serpentarius, Muller und Troschel.

Echinaster serpentarius (Val.) Muller and Troschel, System der Asteriden, p. 24. Perrier, Arch. Zool. Expér., t. iv, p. 370.

A single specimen of this interesting form was collected at Vera Cruz. It corresponds well with Müller and Troschel's description. They described their species from specimens in the Paris Museum, also obtained from Vera Cruz. The specimen collected by the expedition is superficially characterized by the numerous very small, short, blunt spines forming irregular longitudinal and transverse rows upon its dorsal surface, and by the peculiar arrangement of the ambulacral spines. There are four of these spines arranged in a row upon the aboral edge of each adambulacral plate. The innermost spine is the smallest and bears at its base a rudimentary spinelet. Each plate of the series of ventral plates adjoining the adambulacral plates has three or four spines upon its aboral edge. Each of the lateral plates also has a row of three spines upon its aboral edge. The ambulacral, ventral and lateral spines of the arms are very small, but not so small as those of the dorsal surface. The distal portions of all the spines have a rough appearance when viewed with the naked eye, and when examined with the microscope are seen to be thorny. The reticulated skeleton is made up of a number of qudrilateral plates, connected at their angles and arranged in longitudinal rows. The abactinal spines are borne upon the edges of these plates.

The ventral and lateral plates are connected by an intermediate ossicle. Intermediate ossicles occasionally occur between the other plates of the skeleton. The central portion of the surface of these plates is covered with minute tubercles which give them a granulated appearance. Figs. 19, 20 and 21, Pl. VIII, represent dorsal, ventral and lateral views of a portion of the skeleton of an arm, enlarged about four diameters.

The regular arrangement of the plates produces a superficial resemblance to an *Asterias*.

The specimen collected has a diameter of about 50 mm. R=5r.

This species has as yet only been recorded from Vera Cruz. It differs essentially from *Echinaster* as defined by Perrier,[1] Viguier[2] and Sladen,[3] and even as defined by Müller and Troschel[4] themselves, for they say, "in der Haut ein zusammenhängendes netz von Balken," and quadrilateral plates certainly cannot be termed "Balken." The abactinal and lateral skeleton of an *Echinaster* consists of small, narrow, imbricated plates forming an irregular network. The skeleton in this species, on the contrary, consists mainly of quadrilateral plates arranged in regular longitudinal series. It is also distinguished by the minute tuberculation of the plates, the arrangement of the spines along their edges and the thorny character of the distal portion of these spines. I have, therefore, erected a new genus for this species, which may be characterized as follows:—

THYRASTER, n. gen.

Ambulacral pedicles biserial. Actinostomial margin defined by the adambulacral plates. Arms subcylindrical, skeleton composed mainly of quadrilateral plates, united at their angles by imbrication and arranged in longitudinal series. Plates minutely tuberculated, supporting spines upon their edges. Distal portion of the spines microscopically thorny.

I hope at a future period to consider the question of the relationship of *Thyraster* to the Echinasteridæ in general.

Astropecten articulatus, Say, Journ. Acad. Nat. Sci. Phila. (1) Vol. 5, p. 141.
Perrier, Arch. Zool. Exp., Vol. 5, 1876, p. 290.
Astropecten duplicatus Gray, Ann. Mag. Nat. Hist. Vol. VI, 1841, p. 181.
Perrier, op. cit. p. 271.
Astropecten Valenciennii, Muller and Troschel. System der Asteriden, p. 68.
Astropecten variabilis, Lutken, Vidensk. Meddel., 1859, p. 59.

A single specimen of this species was collected at Vera Cruz.

It is found in the West Indies, extending northward to Beaufort, N. C. and southward off the island of Jolbo on the northeast coast of Yucatan.

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[1] Arch. Zool. Exp. t. iv, pp. 283 and 289.
[2] Ibid. t. vii, p. 123.
[3] Challenger Report, pp. xxxviii and 536.
[4] System der Asteriden, p. 22.

Beaufort, N. C. (Nachtrieb). South Carolina (Ives).[1] Georgia and East Florida (Say). Tampa Bay, West Florida (Ives.) Florida Channel (L. Agassiz). Vera Cruz (Müller and Troschel). St. Thomas, St. Croix (Lütken). St. Vincent (Gray). 60 m. N. Ile Jolbo; Banc de Yucatan (Perrier.)

There appears to be no important difference between *Astropecten articulatus* of Say and *Astropecten Valenciennii* of Müller and Troschel. The only supposed difference between the two species was the existence of two rows of spines upon the supero-lateral plates of the latter, in distinction to one row in the former species. But upon examination this character proves to be very variable. Perrier[2] describes a specimen of *Astropecten articulatus* in which the spines upon the supero-marginal plates are entirely lacking, and an examination of the specimens in the collection of this Academy has convinced me that this character is subject to great variation. Both series of spines may be developed along the whole length of the arm or one or both may be more or less imperfectly developed, or according to Professor Perrier they may be both entirely absent. Professor Perrier found upon examination of original specimens that *Astropecten Valenciennii* was identical with *Astropecten duplicatus* of Gray, and *Astropecten variabilis* of Lütken. Müller and Troschel described their species from a specimen obtained at Vera Cruz.

Ophiura cinerea, Muller and Troschel, System der Asteriden, p. 87.

Lyman, Mem. Mus. Comp. Zool., Vol. I, p. 27.

Ophioderma Antillarum, Lutken, Vidensk. Selsk. Skrift. Bd. V., 1859, p. 190, Tab. 1, fig. 1.

A single specimen of this species was brought up with a coral at Vera Cruz, from about eight feet of water.

It is distributed throughout the West Indies, upon the Florida reefs, and southward as far as the Abrolhos Islands, Brazil.

Tortugas, Fla.; Key Biscayne, Fla.; St. Thomas; Jeremie, Hayti; south of Vera Cruz in the Gulf of Mexico; Aspinwall; Bahia, Brazil, 7–20 faths. (Lyman). St. Jan, 1 fath.; St. Thomas, 1 foot to 4 faths. (Lütken). St. Barthelemy (Ljungnan). Fernando de Noronha; Parahyba do Norte; Plataforma; Mar Grande; Bay of Bahia; Abrolhos Reefs (Rathbun).

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[1] Catalogue of the Asteroidea and Ophiuroidea in the collection of the Academy of Natural Sciences of Philadelphia, Proc. Acad. Nat. Sci. Phila. 1889, p. 169.

[2] Arch. Zool. Exp. t. 5, 1876, p. 291.

Ophiothrix angulata, Say, Jour. Acad. Nat. Sci. Phila. (1) V, p. 145.
Lyman, Mem. Mus. Comp. Zool., Vol. I, p. 162, Pl. II, Figs 1–3; "Challenger" Report on the Ophiuroidea, 1882, p. 219.

A young specimen was brought up on a coral from about eight feet of water in the harbor of Vera Cruz.

This species is found abundantly throughout the West Indies, and extends northward to Beaufort N. C., and southward to Rio Janeiro.

Beaufort, N. C. (Nachtrieb). Fort Johnston, N. C. (Ayres). Charleston S. C. (Say). Waccamaw, S. C.; Key West, Fla. (Lyman). Charlotte Harbor, Fla.; Tortugas (Ayres). Off Bermudas, 32 faths. (Lyman). Guadiana Bay, Cuba; Bahia Honda., Cuba; Jeremie, Hayti; St. Thomas (Lyman). St. Barthelemy; Tortola, (Ljungman). Sombrero, 54 faths.; Barbadoes, 100 faths. (Lyman). Mugeres Island, Yucatan; Aspinwall; Fernando Noronha, (Lyman). Parahyba do Norte; Pernambuco; Rio Formoso; Plataforma; Mar Grande, Mapelle; Bay of Bahia; Abrolhos Islands (Rathbun). Off Bahia, 7–20 faths.; Off Cape Frio, Brazil, 35 faths. (Lyman). Rio de Janeiro (Rathbun).

GEOGRAPHICAL DISTRIBUTION.

In indicating the geographical range of the species collected by the Expedition, I have endeavored to confine the area of distribution, so that it should include only those localities in which the species are constantly found in greater or lesser abundance; and I have, as far as the data at my disposal would permit, avoided including those localities in which only occasional or dead specimens occur. A good illustration of this principle is the distribution of *Mellita pentapora*. Dead specimens are found as far North as Vineyard Sound, but living specimens according to Professor Verrill do not occur north of Cape Hatteras, and I have therefore given Cape Hatteras as the northern limit of distribution of this species. The amount of collecting that has been done upon the shores of the southern United States is quite small, and it is therefore difficult to define with accuracy the limit of the northerly distribution of West Indian Echinoderms. The same observation with respect to the southern limit of distribution applies to the coast of Brazil, although much valuable information has been acquired through the collections made by Mr. John C. Branner, Professor Chas. Fred. Hartt, and their associates and assistants. It is desirable that thorough collections should be made on these coasts and also in the West Indian islands, with the object of ascertaining accurately the distribution of the littoral Echinoderms in the Western tropical Atlantic region.

A paper by Mr. H. F. Nachtrieb[1] upon the Echinoderms collected at Beaufort, N. C. in connection with the Marine Laboratory of the John Hopkins University, throws some light upon the question of the northern limit of the West Indian Echinoderm shore fauna. Of the three species of starfish collected, two belong to the West Indian fauna and one to the northern; of the Ophiurans the three species are all West Indian; of the sea-urchins three species are West Indian and one northern. The Holothurians are unidentified. Thus it is seen that at Beaufort, which is about 70 miles to the southeast of Cape Hatteras, the Echinoderm fauna is distinctly West Indian.

Commander Bartlett[2] of the United States Coast and Geodetic Survey, in connection with the work of the steamer "Blake" has come to the conclusion that the Arctic or Labrador current does not extend south of Cape Hatteras, but at that point goes under the Gulf Stream and to the eastward, being deflected that way by the form of the Blake plateau. He also states that the Gulf Stream has for its western bank the 100 fathom curve which is on an average about 70 miles from the shore as far north as Cape Hatteras, and that the water inside of the 100 fathom line to the shore, appears to be an overflow of the stream as the temperature to five, ten and fifteen fathoms is nearly as high as that found in the stream. North of Cape Hatteras the Gulf Stream is deflected northeastwards and is separated from the coast by the cold Labrador current. It will be apparent from the above statements that Cape Hatteras marks the northern limit of an area of temperature which may be regarded as essentially that of the West Indian littoral region.

The following list of species collected by the Expedition will readily show their distribution.

Holothuria Heilprini.	Port of Silam, northern coast of Yucatan.
Holothuria Silamensis.	
Holothuria nitida.	

Diadema setosum, West Indies, Cape Florida to Fernando de Noronha.

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[1] Notes on Echinoderms obtained at Beaufort, N. C., Johns Hopkins University. Studies from the Biological Laboratory, Vol. iv. p. 81.

[2] Report of the United States Coast and Geodetic Survey, 1882, p. 37 and "Three cruises of the Blake" by Alexander Agassiz p. 257, fig. 176.

Echinometra subangularis, West Indies, Charleston, S. C. to Desterro, Brazil.

Toxopneustes variegatus, West Indies, Beaufort, N. C. to Armação, Brazil.

Mellita pentapora, West Indies, Cape Hatteras to Itabapuana, Brazil.

Thyraster serpentarius, Vera Cruz.

Echinaster Brasiliensis, West Indies, Florida Channel to Rio Janeiro.

Astropecten articulatus, West Indies, Beaufort, N. C. to off Jolbo, off the N. E. coast of Yucatan.

Luidia alternata, West Indies, Florida to Bahia, Brazil.

Ophiura cinerea, West Indies, Florida Reefs to Abrolhos Islands.

Ophiothrix angulata, West Indies, Beaufort, N. C. to Rio Janeiro.

It will be observed that with the exception of the Holothurians, and *Thyraster serpentarius,* the Echinoderms obtained are all common to the West Indies, and their method of distribution points to this region as their center of propagation. Four of them have a longitudinal range of about 4,000 miles, extending approximately from Cape Hatteras in the north to Santa Catharina in the south. The others have a more limited range, one extending from the Florida channel to Rio Janeiro, two from Florida to Bahia, one from Florida to Fernando de Noronha, and one is only known as yet from Vera Cruz. A range is thus indicated, comprehending all the species referred to, limited by Cape Hatteras in the north, and the island of Santa Catharina, off the southern portion of Brazil, in the south. These northern and southern limits represent points crossed by the isotherms of 15° C. (60° Fahr.) in both hemispheres during the coldest month of the year. South and north of these localities respectively the surface temperature of the water never falls below this degree of warmth. Of the five littoral species of Echini, however, recorded by Professor Alexander Agassiz from Cape Dos Bahias, Patagonia, in his Report upon the Echini of the Hassler Expedition, two belong to the West Indian fauna. The question is thus raised of the true southern limit of the West Indian fauna.

The localized habitat of the Holothurians collected is in striking contrast to the broad ranges of the other species. This localization is largely characteristic of the shallow water Holothuroidea. The greater number of known species are confined either to one locality or to a very circumscribed area. This fact was illustrated by the

Echinoderms collected by the Academy's Expedition to the Bermuda Islands in 1888 under the direction of Professor Angelo Heilprin. The species obtained with the exception of the Holothurians were all common, widely distributed forms, but of the six species of the latter four were new. The limited habitat of so many members of this group is probably due to their poor locomotory qualifications.

It is of some interest to make a comparison of the species collected in Yucatan, at Vera Cruz and in Bermuda. The Holothurians found at Yucatan, three species of the genus *Holothuria*, are distinct from the three species of the same genus collected in Bermuda. Three other species representing the genera *Semperia* and *Stichopus* were also obtained in Bermuda. Of the Sea Urchins, one species is common to Yucatan and Bermuda, two species are common to Vera Cruz and Bermuda. *Mellita pentaporus* at Vera Cruz is represented by *Mellita sexforis* in Bermuda: and two species were found in Bermuda which were not obtained in Yucatan or at Vera Cruz. The two species of starfishes from Yucatan, and the two from Vera Cruz are generically different from the two species obtained at Bermuda. The two species of Ophiurans differ generically from the six species collected in Bermuda. Considerable local difference in the littoral Echinoderm fauna is thus seen to exist between these three portions of the West Indian region.

It is remarkable that the common West Indian species *Toxopneustes variegatus* was not collected at Vera Cruz, although three other species of sea urchin are abundant in that locality. It was the only species of sea urchin collected in Yucatan. Can it be that at Vera Cruz its place is taken by *Echinometra subangularis?*

It is a noteworthy fact that although *Diadema setosum* is found in the West Indies, upon the West African coast and throughout the Indo-Pacific region, it is absent upon the west coast of America. A large number of species of Holothurians, Sea Urchins, Starfishes and Ophiurans, although not found in the Atlantic tropical region, are similarly distributed throughout the entire Indo-Pacific region, being present in the islands of the Pacific, the East Indies, the Indian Ocean and upon the Eastern Coast of Africa, and resemble *Diadema setosum* in their absence, with a few rare exceptions, from the West Coast of America. This interesting fact appears to me explicable in the following way:— The littoral species of the tropical regions are probably distributed principally by the warm equatorial currents flowing from east to west. The equatorial currents of the Pacific arise upon the western coast of America,[1] and flowing through the islands of Polynesia and the East Indies distribute their species westward, and it would be naturally supposed that the species occupying the area where the currents arise would be also carried in that direction. This, however, is not so; probably for two reasons. 1. The equatorial counter-current impinges upon the greater portion of the western coast of Central America and produces a quiet area in which there is apparently little circulatory motion. Further, the north and south equatorial currents arise respectively off the coasts of Lower California and Peru, and probably come little into contact with the littoral fauna of west Central America. 2. The eastern portion of the Pacific Ocean contains very few islands which could serve as connecting points in the distribution of littoral forms. These are probably the reasons why the west Central American forms are not found in the Indo-Pacific region. The equatorial counter-current, which could form the only possible means of communication from the Indo-Pacific tropical region to the west Central American tropical region, traverses a tract in which there are only a few scattered islands which are probably not sufficient in number to bring about the introduction of the fauna of the one region into the other.

GENERAL LITERATURE OF THE ECHINODERM FAUNA OF THE WEST INDIAN REGION (NOT INCLUDING THE CRINOIDS).

1825. Thomas Say. On the species of the Linnæan genus Asterias inhabiting the Coast of the United States. Jour. Acad. Nat. Sci. Phila. (1), Vol. 5, p. 141.
1826. Thomas Say. On the species of Linnæan genus Echinus inhabiting the Coast of the United States. Ibid, p. 225.
1851. L. F. Pourtalès. On the Holothuriæ of the Atlantic Coast of the United States. Proc. Amer. Assoc., 1851, p, 5.
1856. Chr. Lütken. Contributions to the Knowledge of the Serpent-Stars. II. Review of the West Indian Ophiurans. Vidensk. Meddel. Kjöbenhavn, p. 1.
1859. Chr. Lütken. Contributions to the Knowledge of the Starfishes of the Coasts of Central and South America. Vidensk. Meddel. Kjöbenhavn, p. 25.
1859. Chr. Lütken. Addimenta ad historiam ophiuridarum. II. Description of little known Serpent-Stars from the West Indies

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[1] See Dr. Van Bebber, Lehrbuch der Meteorologie, Stuttgart, 1890, Tab. ii.

and the West Coast of Central America. Vidensk. Selsk. Skrift. Kjöbehavn, p. 179.

1865. Theodore Lyman. Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College. No. 1 Ophiuridæ and Astrophytidæ. Mem. Mus. Comp. Zool., Vol. 1. Includes a description of the principal West Indian Ophiurans.

1867. A. E. Verrill. Comparison of the Tropical Echinoderm Faunæ of the East and West Coasts of America, Trans. Conn. Acad., Vol. 1, p. 339.

Notice of the Corals and Echinoderms collected by Prof. C. E. Hartt, at the Abrolhos Reefs, Province of Bahia, Brazil, 1867, Ibid, p. 357.

1869. Alexander Agassiz. Preliminary Report on the Echini and Starfishes dredged in deep water between Cuba and the Florida Reef by L. F. de Pourtalès, Assist. U. S. Coast Survey, Bull. Mus. Comp. Zool., Vol. 1, p. 253.

1869. Theodore Lyman. Preliminary Report on the Ophiuridæ and Astrophytidæ dredged in deep water between Cuba and the Florida Reef by L. F. de Pourtalès, Assist. U. S. Coast Survey. Ibid, p. 309.

1869. L. F. de Pourtalès. List of Holothuridæ from the deep sea dredgings of the United States Coast Survey. Ibid, p. 359.

1871. Axel. Vilh. Ljungman. Förteckning öfver ute Vestindien af Dr. A. Goës samt under Korvetten Josefinas Expedition in Atlantiska Oceanen samlade Ophiurider. Ofvers. Kongl. Ventensk. Akad. Förhandl. No. 6. Stockholm.

1871. Theodore Lyman. Supplement to the Ophiuridæ and Astrophytidæ, Mem. Mus. Comp. Zool., Vol. II, No. 6. Description of deep sea and shallow water Ophiurans from Florida.

1871. Chr. Lütken. Fortsatte kutiske og beskrivende Bidrag til Kundskal an Söstjernerne (Asteriderne) Vidensk. Meddel. Kjöbehavn. Includes a revison of the tropical American species of Echinaster.

1872. Alexander Agassiz. Echini of the Eastern Coasts of the United States together with a report on the deep sea Echini collected in the straits of Florida by L. F. de Pourtalès Assist., U. S. Coast Survey in the years 1867–1868. Mem. Mus. Comp. Zool., Vol. III, Part II.

1874. The Zoological Results of the Hassler Expedition.
i. Alexander Agassiz and L. F. de Pourtalès. Echini Crinoids and Corals.
ii. Theodore Lyman. Ophiuridæ and Astrophytidæ, including those dredged by the late Dr. Stimpson. Mem. Mus. Comp. Zool., Vol. IV. Includes descriptions of West Indian species.

1878. Edmund Perrier. Etude sur la répartition géographique des Astérides. Nouv. Arch. Mus. Hist. Nat. (2) t. 1, p. 1.

1879. Richard Rathbun. A list of the Brazilian Echinoderms with notes on their distribution, etc. Trans. Conn. Acad. vol. 5, p. 139.

1879. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico, by the United States Coast Survey steamer "Blake," Lieut.-Commander C. D. Sigsbee U. S. N. commanding. II, Bull. Mus. Comp. Zool. vol. 5, p. 181.
Alexander Agassiz. Report on the Echini.
L. F. de Pourtalès. Crinoids and Corals.
Theodore Lyman. Ophiurans.

1881. Alexander Agassiz. Report on the Echinoidea dredged by H. M. S. Challenger during the years 1873–1876.

1882. Theodore Lyman. Report on the Ophiuroidea, dredged by H. M. S. Challenger during the years 1873–1876.

1882. Hubert Ludwig. Verzeichniss der von Prof. Dr. Ed. Van Beneden an der Küste von Brasilien gesammelten Echinodermen. Mem. Cour. Acad. Roy. Belgique, Vol. XLIV, No. 5.

1883. Alexander Agassiz. Reports on the Results of Dredging under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877–78), in the Caribbean Sea (1878–79) and along the Atlantic Coast of the United States (1880), by the U. S. Coast Survey Steamer "Blake." Report on the Echini. Mem. Mus. Comp. Zool., Vol. X, No. 1.

1884. Ed. Perrier. Memoire sur les étoiles de mer recueillies dans la mer des antilles et le Golfe de Mexique. Nouv. Arch. Mus. Hist. Nat. (2), t. vi.

1885. Richard Rathbun. Report upon the Echini collected by the U. S. Fish Commission Steamer "Albatross" in the Caribbean Sea and Gulf of Mexico, January to May, 1884, Proc. U. S. Nat. Mus., Vol. viii, p. 83.

Report upon the Echini collected by the U. S. Fish Commission Steamer " Albatross" in the Gulf of Mexico from January to March, 1885, ibid. p. 606.

1886. Hjalmar Théel. Report on the Holothuroidea dredged by H. M. S. Challenger during the years 1873–1876. Includes faunal lists and description of West Indian species.

1886. Hjalmar Théel, Report on the Holothuroidea, dredged by the " Blake." Bull. Mus. Comp. Zool. Vol. xiii, p. 1. Report upon species collected in the West Indian region.

1887. H. F. Nachtrieb. Notes on Echinoderms obtained at Beaufort, N. C. Johns Hopkins University. Studies from the Biological Laboratory, Vol. iv, p. 81.

1888. Angelo Heilprin. Contributions to the Natural History of the Bermuda Islands. Proc. Acad. Nat. Sci. Phila. p. 309.

1889. W. Percy Sladen. Report on the Asteroidea collected by H. M. S. Challenger during the years 1873–1876. Includes faunal list and description of West Indian species.

EXPLANATION OF PLATE VIII.

Fig. 1. *Holothuria Heilprini*, side view, natural size. Drawn from the contracted alcoholic specimen.

Fig. 2. Perfect table viewed from the side, above and below.

Fig. 3. Imperfect table from around the disks of the pedicels, viewed from the side.

Fig. 4. Rib-like rods of the papillæ.

Fig. 5. Two segments of calcareous ring.

Fig. 6. Rosettes.

Fig. 7. *Holothuria Silamensis.* Two segments of the calcareous ring.

Fig. 8. Rib-like rods of the papillæ.

Fig. 9. Rosettes.

Fig. 10. *Holothuria nitida.* Perfect table, viewed from the side, above and below.

Fig. 11. One of the imperfect tables occurring around the disk of the pedicels, viewed from the side.

Fig. 12. Rib-like rod from the papillæ.

Fig. 13. Two segments of the calcareous ring.

Fig. 14. Small common rosettes.

Fig. 15. Larger uncommon rosettes.

Fig. 16. *Echinaster Brasiliensis* natural size, dorsal surface.

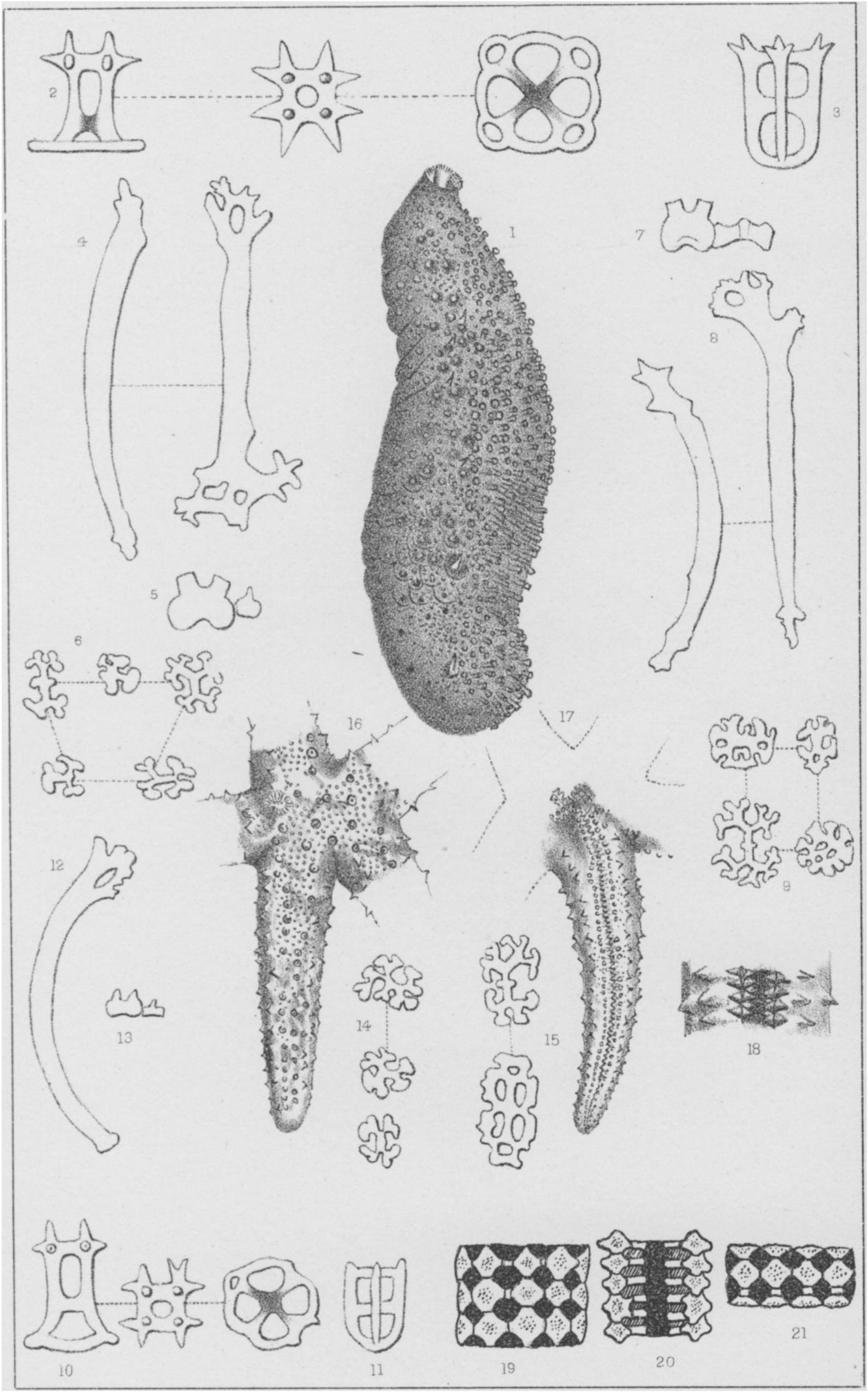
Fig. 17. Ventral surface.

Fig. 18. A portion of the ventral surface, enlarged two diameters to show the three rows of ambulacral spines.

Fig. 19. *Thyraster serpentarius.* Portion of the dorsal skeleton of an arm, enlarged about four diameters.

Fig. 20. Portion of the ventral skeleton of same.

Fig. 21. Portion of the lateral skeleton of same.



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IVES, MEXICAN ECHINODERMS.